DOCUMENT RESUME

ED 167 484 SP 011 454

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TITLE Acquisition of Higher Order Intellectual Skills Through a Mastery Learning Paradigm.
SPONS AGENCY Texas A and M Univ., College Station. Coll. of Education.
PUB DATE 77
NOTE 19p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Academic Achievement; *Cognitive Development; Course Organization; Educational Strategies; *Interval Pacing; *Mastery Learning; Teacher Education; *Time Factors (Learning)

ABSTRACT

This investigation was structured to determine if the acquisition of higher order intellectual processes is tenable for teaching candidates when the independent variables are unit pacing and different remediation strategies for mastery learning. Teaching candidates enrolled in a generic teaching methods course constituted the sample. Nearly half of the participants were concurrently enrolled in student teaching which began six weeks into the semester as a full day-full time experience. The remaining subjects were enrolled in one of two conventionally scheduled courses that met for the entire semester for three one-hour sessions per week. The beginning and conclusion of this study was signaled by the administration of a higher order cognitive achievement test. Treatment variation with respect to remediation strategies for mastery learning occurred after the formative test was administered for each unit. The significant finding in this investigation suggests that compressing the curriculum experiences into a time period that decreases the number of days, but not the actual class hours devoted to curriculum components, reduces performance with respect to higher order cognitive skills. (JD)

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ED167484

Acquisition of Higher Order Intellectual Skills Through a Mastery Learning Paradigm

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This investigation was structured to determine if the acquisition of higher order intellectual processes is tenable for secondary level teaching candidates when the independent variables are unit pacing and different remediation strategies for mastery learning.

Gain scores resulting from two administrations of an achievement test were used as the dependent variable while the independent variables were unit pacing and remediation strategies. The change scores were analyzed with a 2 X 2 analysis of variance procedure. A significant F ratio (4.92, p=.03) resulted when the influence of unit pacing was examined. The F ratios comparing the effect of different remediation strategies (F=.28) and the interaction between unit pacing and remediation strategy (F=.19) were not statistically significant. The significant finding in this investigation suggests that compressing the curriculum experiences into a time period which decreases the number of days, but not the actual class hours devoted to curricular components reduces performance with respect to higher order cognitive skills.

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SP011 454

This investigation was funded by a University Research-College of Education Research Grant, Texas A&M University.

Reviews of research on Mastery Learning have indicated these strategies have consistently enhanced student achievement under a variety of conditions (3, 4, 5, 7, 17). This generalization appears to be valid whether the instructional strategy complies with the requirements of Keller's Personalized System of Instruction-PSI (16) or Bloom's Learning For Mastery-LFM approach (6). An oft-cited theoretical basis for these mastery strategies and variations of these strategies is Carroll's conceptual model of school learning (9). In this model, Carroll proposes that student learning is a function of time (namely, the time a student is willing to spend on the learning task, the time a teacher devotes to instruction, the time necessary for learning), the quality of instruction, and the students' ability to learn.

As a result of Carroll's model, investigators have examined various instructional acts and techniques to determine which factors most affect the quality of instruction. Bloom (7: 134) suggests in support of his model of school learning that cues-participation-reinforcement are essential components of a quality instructional system, with feedback and corrective procedures being used liberally to ensure that each student receives optimal instruction. That quality of instruction is a major variable in determining the history of the learner within a set of learning experiences is attested to by the emphasis placed on knowledge of prerequisites for a learning task (7, 12, 13). Prerequisite knowledges and skills or the previous learning history does set limits on the student's ability to learn a particular learning task. In support of this

assertion,Bloom (7:47) reports that cognitive entry behaviors account for about 50 percent of the variation in achievement on sets of learning tasks.

Instructional research has not been limited to the aforementioned dimensions of Carroll's model. Substantial effort has been expended on the function of time affecting student learning. Time referenced components in mastery learning strategies such as, unit length, unit pacing, learning time, and time devoted to management of learners compared to time spent on the management of learning have been examined extensively. One line of research has determined that mastery strategies may have a homogenizing effect on individual differences concerning study time. It has been found that reductions in study time differences among students have resulted because additional study time for slower learners was provided initially in the instructional program. Another line of investigations has examined class time utilization by students and teacher. Preliminary findings suggest that greater student achievement result when teachers spend more time on the management of learning rather than attending to the management of learners(5).

Pacing of instruction (Self pacing, unit length variation) is another time-related variable which has been investigated to some extent with mastery learning strategies (17). However, the influence of reducing the time between learning experiences associated with a mastery learning task has not been examined extensively; especially as to how pacing may affect attainment of higher order intellectual processes. Few mastery learning investigations have been reported which specifically address achievement of higher order intellectual processes (application,

analysis, synthesis, evaluation) as the dependent variable. Moreover, none of these investigations have been in the context of a teacher preparation program. While the instances of reported research on attainment of higher order intellectual processes are diminutive in comparison to the total body of published research on mastery learning, Block and Burns (5) contend that mastery approaches help students acquire higher-order learning and maintain long term facility with high order processes gained through a mastery approach. Given the present state of the literature on mastery learning, this investigation was structured to:

> determine if the acquisition of higher order intellectual processes is tenable for secondary level teaching candidates when the independent variables are unit pacing and different remediation strategies for mastery learning.

Method

Subjects

This investigation was conducted under the auspices of an educational curriculum and instruction department at a southwestern university accredited by the Southern Association of Colleges and Universities and the National Council for Accreditation of Teacher Education. One hundred twenty-three teaching candidates (junior and senior classfication) enrolled in a generic teaching methods course during the Spring term-1977, constituted the sample. Nearly half of the candidates (57) were concurrently enrolled in student teaching; which commenced 6 weeks into the semester as a full day-full time experience. During the initial 6 weeks of the semester, these subjects completed all course requirements for the generic methods course in one of two course sections which met for 1 1/2 hours/day. The remaining subjects (66) were enrolled in one of two conventionally scheduled courses which met for the entire semester (15 weeks) for three

1 hour sessions/week. Although scheduled differently, each of the four course sections provided 45 clock hours of class contact.

The 57 teaching candidates enrolled in the 6 week sections were randomly assigned into either the mastery group (N=27) or active control group (N=30). Unfortunately, scheduling dictated the full term sections be designated as mastery (N=40) or active control (N=26) for class sections, intoto. Given these assignment procedures group equivalence could not be assumed, nor could the results of this investigation be generalized to other settings.

Treatment

All four treatment groups, mastery (6 week, 15 week), and active control (6 week, 15 week), experienced five identical curricular components and formative tests based on a comprehensive model of teaching (1). This model conceptualizes teaching as a series of events requiring five different instructional skills by the teacher, namely, Establishing Performance Objectives, Diagnosing Learners, Selecting Instructional Strategies, Interacting with Learners, and Evaluating the Effectiveness of Instruction. Each curricular component consisted of performance objectives ranging from 5 objectives for Selecting Instructional Strategies to 8 objectives for Interacting with Learners. Textual materials for each component were of college level readability and ranged from 24 to 59 pages for Establishing Performance Objectives and Evaluating the Effectiveness of Instruction, respectively. Small group and individually structured application activities were used extensively in all treatment groups during the scheduled class sessions.

Without exception all treatment groups were paced by the course instructors. Activities involving the total class membership were uniformly employed in all class periods across all treatment groups for varying amounts of time. Comparable schedules of instruction were maintained between the

treatment groups of equal length, with scheduled formative test administrations and remediation periods being held constant. Treatment variation with respect to remediation strategies for mastery learning occurred after the formative test was administered for each unit. Depending on group assignment, one of the following remediation strategies was recommended if a teaching candidate's performance was below the criterion levels prescribed by the performance objectives for that unit. Although remediation activities outlined in the following two treatments was not mandatory for students who did not achieve one or more objectives on formative tests, participation was high. Undoubtedly, motivation to participate in the remediation treatments was enhanced by a course grading policy which designated letter grades in terms of the number of performance objectives achieved by a teaching candidate.

Mastery Treatment Groups. This experimental treatment was designed to incorporate many aspects of the Personalized System of Instruction (16) approach to mastery learning. Teaching candidates who did not attain mastery on the formative test were given instructions to repeat the reading assignments and confer with the course instructor regarding those objectives not achieved on the initial formative test. After a brief remediation period (2 class periods), these students were administered an alternate form of the formative test. The administration of a second formative test marked the conclusion of this remediation treatment for the curricular component under consideration. This remediation-retesting process was repeated for each of the five curricular components in the course.

Active Control Groups

Erring teaching candidates in these treatment groups received no additional instruction on the curricular component objectives following the initial formative test. Rather, these students were given optional report

assignments related in a general sense to the curricular component to improve their course grade and to enhance their competence with the cognitive skills specified in the objectives. An example of such an assignment and related directions is:

> Directions
>
> The attached assignment provides you with an opportunity to achieve grade credit in place of objectives missed on the formative test. Credit will be awarded on the basis of acceptable written reports. Each paper is to be typewritten and is to be between two to three pages in length. Evaluation of the paper will be based on accuracy of substance and mechanical writing skills. More than five mechanical errors (misspelling, punctuation errors, grammatical errors) will result in no grade credit being awarded for the paper.
>
> Assignment
>
> Read Chapter 1 - Gagne, Robert M., Briggs, Leslie J. Principles of Instructional Design (New York: Holt, Rinehart & Winston) 1974.
>
> Discuss the relation between the following concepts as they relate to instruction: Basic assumptions about instructional design, learning principles, internal processes in learning, and learning emphases in instruction.

In order to maintain parallel time requirements for remediation treatments, these reports had to be submitted within three class periods from the date of assignment. The submission of optional assignment papers was the terminal act for remediating a curricular component. Similar to the mastery treatment, this optional assignment procedure was repeated for each of the five curricular components.

The beginning and conclusion of this investigation was signaled by the administration of a higher order cognitive achievement test. This test was initially administered at the beginning of the semester for all four treatment groups, and readministered the final day each treatment group convened, i.e., end of 6 weeks and 15 weeks, respectively. Data obtained from the dual administration of this instrument were used to produce gain

scores which served as the dependent variable for this investigation.

Instrumentation

The higher order achievement test developed for this investigation employed a four foil multiple-choice format. The multiple-choice items included single, independent test items as well as interpretive exercises. An interpretive exercise in contrast to single test items contain a number of test items based on a common set of data. Gronlund (15) maintains the interpretive exercise has at least one distinct advantage over essay items in measuring higher order cognitive skills, that is, the structure provided by the test. Test respondents were not free to redefine the problem, rather teaching candidates had to demonstrate the specific cognitive skills called for by the interpretive exercise. Further, this format made possible the use of objective scoring procedures.

The skill requirement of a particular higher order cognitive level was considered in framing each item which corresponded to the format suggestions presented by Bloom, Hastings, and Madaus (8). A minimum of two items were developed for each of the four higher cognitive level (application, analysis, synthesis, evaluation) for each of the five curricular components. Additional items were developed to measure competence in areas of specific interest within the five instructional components resulting in the original test containing 62 items. This instrument was then submitted to a review panel of six members, three of whom had previously taught the generic methods course and were very familiar with the content and higher order cognitive skills. The other three panel members were less familiar with the actual course content but understood well the intent of the investigation. The panel was asked to determine the face validity of the test attending carefully to whether the items would in fact, measure attainment of higher order cognitive skills. Panel members offered suggestions which were incorporated before the instrument was submitted to a pilot test.

In December 1976, the revised instrument was pilot tested with 94 student teachers who had just completed the generic methods course and student teaching. Item analysis statistics and an estimate of reliability, Cronbach's Alpha (10) (r=.71), were determined. Given these values a number of items were deleted resulting in the final draft of the instrument containing 40 test items. A summary of a table of specifications for the final draft of the instrument is presented in Table 1. Rather than an equal distribution of items representing each instructional component at each cognitive level being included, the item selection process, given the item analysis of the pilot data, yielded 1/2 of the items in the analysis cognitive level and 3/8 of the items related to the Developing Performance Objectives curriculum component.

Findings

Gain scores resulting from the two administrations of the achievement test were used as the dependent variable while the independent variables were unit pacing and remediation strategies. The gain scores were analyzed with a 2 x 2 analysis of variance procedure. A significant F ratio ($F = 4.92$, $p = .03$) resulted when the influence of unit pacing was examined. The mean gain score for candidates enrolled in the 6 week sections was determined to be 3.20 while the average gain for students enrolled in the full semester sections was 5.45. The F ratios comparing the effects of different remediation strategies ($F = .28$) and the interaction between unit pacing and remediation strategy ($F = .79$) were not statistically significant. The mean gain scores for the remediation treatment groups were: mastery (3.71) and active control (4.45), respectively.

Given the significant F ratio regarding the independent variable-unit pacing, additional analyses of the achievement data were undertaken. Five analysis of variance procedures were made to determine the effect of unit pacing on learner achievement by curriculum component. Results from these

analyses are presented in Table 2.

Obviously, the initial component, Establishing Performance Objectives, was the source of most pronounced differences between the 6 week and 15 week treatments. This finding is not too surprising since 3/8 of the items on the test were related to this component. The use of gain scores as the dependent variable, coupled with the smaller number of test items/component combined to reduce the range of scores possible for the other curricular components, thereby reducing the potential variance between treatments. It is conceivable that other components would have registered greater differences had the number of items representing that component been greater.

A second analysis was initiated to determine whether remediation treatments as designed for this investigation would affect the final performance ratings of student teachers by university supervisors. For this analysis, only the teaching candidates in the 6 week treatment groups were used, since only 15% of the teaching candidates in the 15 week treatment were concurrently enrolled in student teaching. Results of this analysis are reported in Table 3. Since the F ratio did not meet the Alpha level of .05, the observed difference can be explained on the basis of random variation (error variance) rather than be attributed to treatment effects.

Discussion

The results of this investigation do not negate the value of remediation strategies influencing the attainment of higher order cognitive skills. While the effect of different remediation treatments did not produce significant findings, substantial improvement in group performance did occur across both remediation treatments. These gain scores represent an increase of higher order skill attainment ranging from 14.7 to 19.8 percent

for the remediation treatments. These changes are noteworthy for two reasons: 1. The cognitive skills addressed on the formative tests for each curricular component were largely restricted to lower order skills (knowledge, comprehension) or stated another way the generic methods course requirements did not emphasize attainment of higher order skills. and 2. While the identification labels attached to the remediation treatments suggest a substantial difference (mastery, active control) between treatments, in essence, both treatments were similar in many characteristics. Individuals in each treatment group were provided corrective feedback after the initial formative test regarding the appropriateness of their responses; additional study time was provided to erring students in both remediation treatments; and reinforcement was possible for students attending to the remediation activities in both treatment groups.

The similarity of achievement gains between remediation treatment groups reflects perhaps a design error, in that greater variation between treatments should have been taken into account in developing the treatments. In our thinking, the comparable gain scores do not indicate the treatments were ineffective in producing substantial changes in higher order cognitive skill capabilities of teaching candidates.

The significant findings in this investigation do suggest that compressing the curriculum experiences into a time period which decreases the number of days, but not the actual class hours devoted to curricular components, reduces performance with respect to higher order cognitive skills. While a cautionary note is in order since this interpretation must be considered in view of the limitations of the investigation design (non-random assignment);

the overall significant finding and trends indicated by the additional analyses do suggest the need to examine the common practice of a professional education semester organized around an intensive treatment of teaching methods for 6 weeks followed by a full-time student teaching experience for 8 or 9 weeks. This organizational arrangement has been examined with respect to the performance and attitudes of student teachers (3, 10, 11, 13). Findings from these investigations suggest these dependent variables have not been influenced by this arrangement. However, it is possible, given the results of this investigation, that research regarding the temporal arrangement of student teaching experiences have not attended to the most appropriate variable, that is, cognitive growth resulting from methods coursework associated with student teaching. It is feasible, that the temporal organization of a course which compresses the activities from 15 weeks to 6 weeks reduces the teaching candidate's ability to integrate the principles of instruction into higher order cognitive skills. Consequently, it is our recommendation that additional study on the influence of different temporal arrangements of the professional education semester on teaching candidate cognitive achievement be conducted to corroborate or refut these findings.

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Table 1

Summary of Table of Specifications for Higher Order Achievement Test Expressed in Percentages

Cognitive levels	Establishing Performance Objective	Diagnosing Learners	Selecting Instructional Strategies	Interacting with Learners	Evaluating Effectiveness of Instruction	Cumulative percentage by cognitive level.
Application	7.5	5.0	0	2.5	5.0	20.0%
Analysis	27.5	0	0	0	22.5	50.0%
Synthesis	0	7.5	0	0	0	7.5%
Evaluation	2.5	5.0	7.5	7.5	0	22.5%
Cumulative % by Instructional component	37.5	17.5	7.5	10.0	27.5	

Table 2

Summary of Additional Analyses of the Effects of Unit Length on Achievement Gain Scores by Curricular Component

Curricular Component	15 week $\bar{X}$	6 week $\bar{X}$	M.S.	F.	P.
Establishing Per. Objectives	3.05	1.20	75.76	7.31	.008
Diagnosing Learners	.53	.78	1.84	.72	N.S.
Selecting Instructional Strategies	.26	-.10	3.74	3.33	.07
Interacting with Learners	.14	.12	.01	.01	N.S.
Evaluating the Effectiveness of Instruction	1.93	1.52	4.66	.81	N.S.

Table 3

Analysis of Final Supervisor Ratings of Student Teachers Performance by Remediation Treatments.

	Group Means	
	Mastery	Active Control
N	26	29
$\bar{X}$	112.46	116.49
SD	9.06	6.75

Analysis of Variance

source	df	ms	F	p
Treatment	1	233.19	3.71	.06
Error	53	62.78		